Instruction Manual

MODEL 412B

HIGH VOLTAGE
DC POWER SUPPLY

FLUKE

ELECTRONICS FOR INDUSTRY
INSTRUMENTS / COMPONENTS

JOHN FLUKE MFG. CO., INC.
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MODEL 412B

HIGH VOLTAGE DC POWER SUPPLY

412B serial no. 123 and above.

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ADDENDUM TO

SECTION II OPERATING INSTRUCTIONS

HIGH VOLTAGE POWER SUPPLIES AND VOLTAGE DIVIDERS

1. Coaxial cables used to connect the instrument to a load are not provided by John Fluke Mfg. Co., Inc. Procurement of cables and the assembly of mating cable connectors must be carefully undertaken to insure safty of personnel.

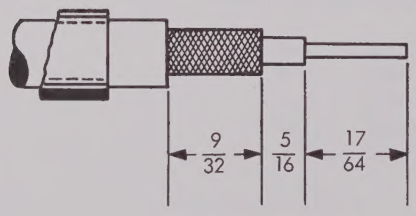
WARNING!

Extreme care should be exercised when utilizing high voltage conductors and connectors. Improper assembly of cable connectors or careless use of high voltage equipment may expose personnel to voltage of lethal magnitude.

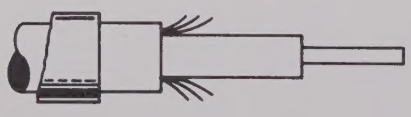
2. General instructions are provided herein for the assembly of two types of cable connectors issued as an accessory item with John Fluke instruments. Additional information on the assembly of these connectors, or on other types of connectors considered for use with the instrument, may be obtained from the cable or connector vending agency.

3. DAGE TYPE 486-1 CONNECTOR ASSEMBLY.

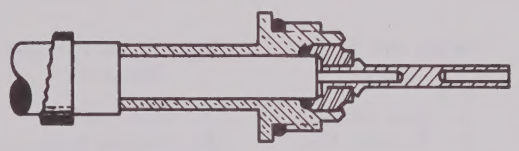
a. Cut cable off square on end. Slide outer sleeve over cable and slide back out of way. Trim cable to dim. shown being careful not to nick center conductor or braid. Tin dip center conductor. Remove all excess solder.



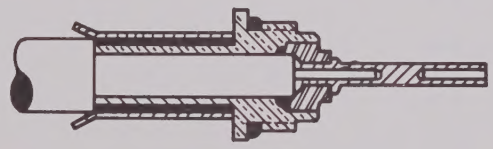
b. Rotate dielectric to slightly flare braid.



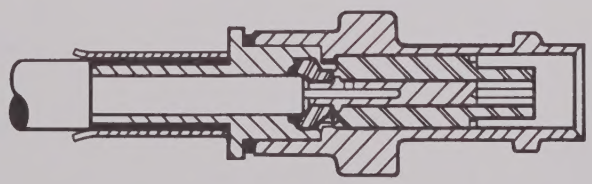
c. Push cable into nut sub-assembly until the center conductor is visible thru hole in contact. Soft solder center conductor thru hole in contact. Remove excess solder. Fold braid down over back end tube of nut. Trim excess braid if necessary.



d. Slide outer sleeves over braid until it is flush against back of nut. Crimp as close to nut as possible using proper crimping tool.



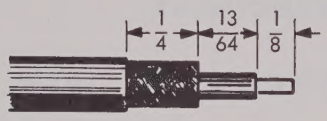
e. Insert finished cable assy. into body either jack or plug and tighten by rotating body. Do not rotate nut sub-assembly.



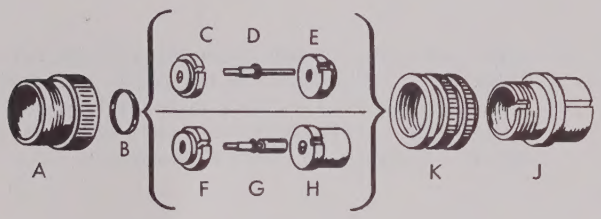
4. AMPHENOL MS 3106A CONNECTOR ASSEMBLY.

a. Strip cable jacket, braid, and dielectric to dimensions shown. All cuts are to be sharp and square. Do not nick braid, dielectric, and center conductor. Tinning of center conductor is not necessary if con-

tact is to be crimped. For solder method, tin center conductor avoiding excessive heat.



b. Disassemble connector by removing the back shell and retainer ring.

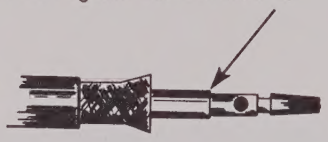


WITH PIN INSERT (Male)		WITH SOCKET INSERT (Female)	
A	Back Shell	A	Back Shell
B	Retainer Ring	B	Retainer Ring
C	Pin Rear Insert	F	Socket Rear Insert
D	Pin Contact	G	Socket Contact
E	Pin Front Insert	H	Socket Front Insert
J	Front Shell	J	Front Shell
K	Coupling Ring	K	Coupling Ring

c. Insert cable thru clamp MS 3057A and rear components of connector. Place the cable center conductor into the socket contact.

d. Soft solder contact to cable center conductor. Do not get any solder on outside surfaces of contact. Avoid excessive heat to prevent swelling or dielectric.

Contact must butt against cable dielectric



e. Provide a connection from the cable shield to the securing bolt of the cable clamp. The connecting copper wire should be approximately 5 inches long and size 14 or larger in diameter. A terminal lug should be used to connect the wire to the clamp. The wire should be carefully soldered to the shield, taking care not to damage the insulation of the cable. Loose ends of the shield should be clipped off to prevent shorting the center conductor or contact to the shield.

f. Assemble the cable connector by placing the contact into the socket front insert, then coupling the back shell to the front shell in the reverse of the disassembly procedure.

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MODEL 412B HIGH VOLTAGE DC POWER SUPPLY

SECTION I

INTRODUCTION AND SPECIFICATIONS

1-1. INTRODUCTION

1-2. GENERAL DESCRIPTION

1-3. The Fluke Model 412B is a High Voltage DC Power Supply having the capability of providing an output of 0 to ±2100 vdc, and 0 to 30 milliamperes. Applications of the 412B include powering photomultiplier tubes, traveling wave tubes and klystrons, and calibration of voltage dividers and voltmeters.

1-4. The Model 412B is a hybrid supply, utilizing the best features of both vacuum tubes and silicon transistors. The use of transistors in the low signal level portions of the instrument eliminates the requirement for a regulated filament supply. The instrument has excellent isolation of the output from variations of either line voltage or load current. Either the + or - output terminal may be grounded. A time-delay relay is incorporated in the input circuitry, which prolongs the life of the high voltage vacuum tubes.

1-5. The power transformer is provided with a dual primary for operation from either 115 or 230 volts. The secondary of the power transformer has taps which are switched according to the selected output voltage. This reduces the amount of power dissipated by the series passing tubes at low output voltages. The 412B is equipped with an over-current relay, which protects the instrument from damage due to excessive load current.

1-6. Precision wirewound resistors are used in all voltage sampling applications, and at other critical places in the circuit. This permits the use of calibrated output voltage controls and ensures excellent long term stability.

1-7. RECEIVING INSPECTION

This instrument has been thoroughly checked and tested before being shipped from the factory. Immediately after receiving the instrument, carefully inspect for damage which may have occurred in transit. If any damage is noted, follow the instructions outlined on the warranty page in the back of this manual.

1-8. SPECIFICATIONS

1-9. ELECTRICAL

OUTPUT VOLTAGE: 0 to ±2100 vdc.

OUTPUT CURRENT: 0 to 30 milliamperes.

OUTPUT POLARITY: + or - grounded by front panel switch.

LINE REGULATION: 0.001% or 2 mv (whichever is greater) for a 10% line change from nominal.

LOAD REGULATION: 0.001% or 5 mv (whichever is greater) for full load change.

STABILITY: ±0.005% per hour; ±0.02% per day after warmup.

RESOLUTION: 5 millivolts.

RIPPLE: Less than 500 uv rms; less than 1 mv peak-to-peak.

VOLTAGE CALIBRATION:
Three 500 volt increments
Five 100 volt increments
Nine 10 volt increments
Nine 1 volt increments
One 0 to 1.2 volt vernier

CALIBRATION ACCURACY: ±0.25% or 100 mv (whichever is greater) with vernier at zero.

OVERCURRENT PROTECTION: Set to latch off at 32 ma load current.

RESETABILITY: ±0.05% or 50 mv (whichever is greater).

RECOVERY TIME: Within 50 microseconds.

WARMUP TIME: 30 minutes to meet specifications.

METER: 2100-0-2100 volts (±3%).

TEMPERATURE COEFFICIENT OF OUTPUT: Less than 20 ppm per ^{O}C from +10^{O}C to +40^{O}C.

INPUT POWER: 115/230 vac ±10%, 50-60 cycles, approximately 300 va at full load. Operation from 400 cycles available on request.

1-10. MECHANICAL

OUTPUT CONNECTORS: One UG931/U front and rear (one mating connector supplied).

HUMIDITY: 0 to 80%.

OPERATING TEMPERATURE: 0^{O}C to +50^{O}C.

STORAGE TEMPERATURE: -20^{O}C to +70^{O}C.

ALTITUDE, OPERATING: 10,000 ft.

ALTITUDE, NON-OPERATING: 50,000 ft.

VIBRATION: MIL-T-945A.

SHOCK: MIL-E-4970A (20 g's, 11 milliseconds).

SIZE: 19" wide by 3-1/2" high by 15" deep. (Rack mount with rubber supports for bench use).

WEIGHT: Approximately 28 pounds.

SECTION II

OPERATING INSTRUCTIONS

2-1. FUNCTION OF EXTERNAL CONTROLS, TERMINALS, AND INDICATORS

2-2. The location, reference designation, and functional description of external controls, terminals, and indicators on the Model 412B are given in Figure 2-1.

CONTROL, TERMINAL, or INDICATOR	LOCATION	REFERENCE DESIGNATION	FUNCTIONAL DESCRIPTION
POWER switch	Front panel	S1	Applies AC line power to the control circuit and to the primary of the transformer.
POWER ON indicator lamp	Front panel	DS1	Illuminates when power is applied to the control circuit and transformer.
HIGH VOLTAGE switch	Front panel	S2	Used to apply transformer power to the high-voltage rectifiers when the STBY/RESET lamp is illuminated.
STBY/RESET indicator lamp	Front panel	DS2	Indicates completion of the time-delay cycle, by illuminating 30 seconds after line power is applied to the 412B. The HIGH-VOLTAGE switch must be set to STBY/RESET for completion of the time-delay cycle.
HIGH VOLTAGE ON indicator lamp	Front panel	DS3	Illuminates when the high voltage is available at the OUTPUT connectors.
POLARITY switch	Front panel	S7	Selects an output either positive or negative with respect to chassis ground.
OUTPUT VOLTAGE dials	Front panel	S3, S4, S5, S6, and R119	The first four dials select the output voltage in three steps of 500 volts, five steps of 100 volts, nine steps of 10 volts, and nine steps of 1 volt, respectively. R119 provides a continuous output range of 0 to 1.2 volts.
Voltmeter	Front panel	M1	Indicates the approximate output voltage from -2.1 to +2.1 kv. Accuracy is ±3% of full scale.
Output connectors	Front and back panels	J1 and J2	UG931/U connectors provided for connecting the load to the instrument. One mating connector is supplied.

Figure 2-1. FUNCTION OF EXTERNAL CONTROLS, TERMINALS, AND INDICATORS

2-3. INPUT POWER

2-4. The 412B may be used on 115/230 vac ±10% at a frequency of 50 to 60 cycles. Like most Fluke instruments, the transformer in the 412B has dual primary windings, which are usually connected in parallel for 115 volt operation. When requested, the primary windings are connected in series for 230 volt operation. If it becomes desirable to change from one operating voltage to the other, remove the top cover of the instrument and change the jumper wires and the fuse as shown on the transformer decal.

2-5. INITIAL OPERATION

2-6. The following procedure is recommended when operating the Model 412B for the first time after shipping or a long period of idleness. This procedure will minimize the possibility of damage resulting from a faulty component.

a. Connect the line plug to a 115 vac power source. If the instrument has been wired for 230 volt operation, connect to 230 vac.

WARNING

This instrument is equipped with a 3-wire line cord, one lead of which is connected to the metal chassis. Connection to a properly-wired outlet automatically connects the chassis of the instrument to earth ground. If an adapter is used to connect the line to a two-contact outlet, the green lead extending from the adapter should be connected to a suitable ground.

b. Set the HIGH VOLTAGE switch to STBY/RESET.

c. Set the POWER switch to ON. The ON lamp will illuminate. After approximately 30 seconds, the time-delay relay will close and the STBY/RESET lamp will illuminate.

d. Set the second OUTPUT VOLTAGE dial to 500.

e. After the STBY/RESET lamp illuminates, set the HIGH VOLTAGE switch to ON. Carefully observe if the HIGH VOLTAGE ON lamp illuminates and if the panel meter indicates 500 (±63) volts.

CAUTION

If the output exceeds 563 volts, immediately set the HIGH VOLTAGE switch to STBY/RESET.

f. If the output voltage is within tolerance, the power supply may be operated as in paragraph 2-7 or 2-8. If the output is not within tolerance, perform steps g. through i.

g. Set the HIGH VOLTAGE switch to STBY/RESET.

h. Locate and correct the source of trouble. Refer to paragraph 4-5.

i. Repeat the initial operating procedure, steps b. through e.

2-7. OPERATING PROCEDURE

a. Set the POWER switch to ON. The ON lamp will illuminate.

b. Set the HIGH VOLTAGE switch to STBY/RESET. After approximately 30 seconds the time-delay relay will close and the STBY/RESET lamp will illuminate.

c. Set the POLARITY switch to the desired polarity.

d. Set the OUTPUT VOLTAGE dials to the desired output.

CAUTION

Rapidly decreasing the setting of the OUTPUT VOLTAGE dials with the high voltage on may damage the sampling string resistors. When dialing down the output voltage, pause approximately 1/2 second in each switch position.

e. Connect the load circuit securely to the output connector. Check the external circuit for conflicts in grounding before applying power to the load.

WARNING

This power supply can produce lethal voltage. Always set the HIGH VOLTAGE switch to STBY/RESET and wait until the output voltage has decayed to zero before connecting or disconnecting the load.

f. After the STBY/RESET lamp illuminates, set the HIGH VOLTAGE switch to ON. The STBY/RESET lamp will extinguish and the HIGH VOLTAGE ON lamp will illuminate. The panel meter will indicate the approximate output voltage.

NOTE

If the overcurrent trip level has been reduced from the factory setting of 32 ma, it may be necessary to set the HIGH VOLTAGE switch to ON with a reduced output voltage setting, to prevent actuating the overcurrent trip when the HIGH VOLTAGE switch is set to ON. In this case, step d, above, would follow step f. If the HIGH VOLTAGE switch is set to ON immediately after the STBY/RESET lamp illuminates, any overload will cause the output voltage to oscillate between ON and STBY/RESET. The oscillation can be stopped and/or prevented by correcting the overload condition.

g. To remove the high voltage from the output connector, set the HIGH VOLTAGE switch to STBY/RESET.

NOTE

When the HIGH VOLTAGE switch is in the STBY/RESET position, there may be a voltage of 2 to 3 volts present at the output connector, due to grid conduction of the passing tubes.

h. The output polarity of the 412B may be changed at any time when no load is connected to the instrument. When a load is connected, especially one that is highly reactive, the HIGH VOLTAGE switch should be set to STBY/RESET, or the output voltage should be reduced to 500 volts, before changing the output polarity. If the polarity is switched at high output voltages with reactive loads, the POLARITY switch may be damaged.

i. The 412B is protected from overload damage by an overcurrent protection circuit which removes power from the high voltage rectifiers at an output current of 32 ma, or at the value set during calibration of the instrument. When the overload trip is acuated, the HIGH VOLTAGE ON lamp will extinguish. The high voltage may be re-applied to the output connectors as follows:

(1) Set the HIGH VOLTAGE switch to STBY/RESET. After approximately 30 seconds the STBY/RESET lamp will illuminate.

(2) Set the HIGH VOLTAGE switch to ON. The STBY/RESET lamp will extinguish and the HIGH VOLTAGE ON lamp will illuminate. The output voltage will be available at the output connectors.

2-8. CALIBRATION OF METERS

2-9. The 412B may be used for direct calibration of dc instruments to an accuracy of 0.25% or 100 mv at 2100 cardinal points, 1 volt apart, from 0 to 2099 volts. The vernier dial provides an additional 1.2 volts of range for calibration between cardinal points. Proceed as follows:

a. Set the POWER switch to ON. The ON lamp will illuminate.

b. Set the HIGH VOLTAGE switch to STBY/RESET. This allows the time-delay relay to start its cycle. After approximately 30 seconds, the time-delay relay will close and the STBY/RESET lamp will illuminate.

c. Set the POLARITY switch to the desired polarity.

d. Connect the instrument being calibrated firmly to the power supply. Check the external circuit for conflicts in grounding before applying power to the load.

e. After the STBY/RESET lamp illuminates, set the HIGH VOLTAGE switch to ON. The STBY/RESET lamp will extinguish and the HIGH VOLTAGE ON lamp will illuminate.

f. Set the first four OUTPUT VOLTAGE dials to the desired cardinal point. Use the last dial if a calibration point between the one volt cardinal points is desired.

g. To remove the output voltage from the output connector, set the HIGH VOLTAGE switch to STBY/RESET.

2-10. When used with a Fluke differential voltmeter and voltage divider, the 412B is capable of calibrating dc instruments from 0 to 2100 volts with an accuracy of 0.01% to 0.06% with 5 millivolts resolution. For calibration of instruments from 0 to 500 volts, proceed as follows:

a. Set the POWER switch to ON. The ON lamp will illuminate.

b. Set the HIGH VOLTAGE switch to STBY/RESET. After approximately 30 seconds, the time-delay relay will close and the STBY/RESET lamp will illuminate.

c. Set the POLARITY switch to the desired polarity.

d. Connect the instrument being calibrated securely to the power supply. Check the external circuit for conflicts in grounding before applying power to the load.

e. Connect a Fluke differential voltmeter to the instrument being calibrated.

f. Set the differential voltmeter to measure the voltage desired at the calibration point.

g. Set the HIGH VOLTAGE switch to ON. The STBY/RESET lamp will extinguish and the HIGH VOLTAGE ON lamp will illuminate.

h. Null the differential voltmeter by adjusting the OUTPUT VOLTAGE dials. The accuracy of the voltage measured is from 0.01% to 0.05%, depending on the accuracy of the differential voltmeter used.

i. Set the HIGH VOLTAGE switch to STBY/RESET.

j. Repeat steps f. through i. for as many calibration points as desired.

2-11. For calibration of instruments from 500 volts to 2100 volts, proceed as follows:

a. Set the POWER switch to ON. The ON lamp will illuminate.

b. Set the HIGH VOLTAGE switch to STBY/RESET. After approximately 30 seconds, the time-delay relay will close and the STBY/RESET lamp will illuminate.

c. Set the POLARITY switch to the desired polarity.

d. Connect the instrument being calibrated firmly to the power supply. Check the external circuit for conflicts in grounding before applying power to the load.

e. Connect a Fluke Model 80E Voltage Divider to the instrument being calibrated, and connect a differential voltmeter to the 10 volt maximum output divider terminal.

f. Set the differential voltmeter to measure the voltage at the desired calibration point, considering the voltage division ratio of the voltage divider.

g. Set the HIGH VOLTAGE switch to ON. The STBY/RESET lamp will extinguish and the HIGH VOLTAGE ON lamp will illuminate.

h. Null the differential voltmeter by adjusting the OUTPUT VOLTAGE dials. The accuracy of the voltage measured is from ±0.02% to ±0.06%, according to the accuracy of the differential voltmeter and voltage divider used.

i. Set the HIGH VOLTAGE switch to STBY/RESET.

j. Repeat steps f. through i. for as many calibration points as desired.

SECTION III

THEORY OF OPERATION

3-1. INTRODUCTION

3-2. This section of the manual describes the theory of operation of the Model 412B. Reference is made to the functional schematic following Section V. This schematic is intended to aid in understanding the theory of operation, and in troubleshooting.

3-3. CIRCUIT DESCRIPTIONS

3-4. A half-wave rectifier is formed by CR201, R201, R202, and C201, which furnishes dc voltage to the control relays K1, K2, and K201. Approximately 30 seconds after switch S1 is closed, time-delay relay K201 closes, if switch S2 is in the STBY/RESET position. This energizes K1, which opens K1B, removing K201 from the circuit, and closing K1A and K1C, which illuminates DS2. When switch S2 is set to HIGH VOLTAGE ON, relay K2 is energized, which closes K2A and K2B, applying transformer voltage to the high-voltage rectifiers. Lamp DS3 also illuminates. If the instrument cover is removed, interlock switch S8 opens, and the instrument is placed in standby operation.

3-5. Relay K202 provides overcurrent protection. If the output current exceeds approximately 32 milliamperes, relay K202 is actuated, which closes contacts K202A. This de-energizes K1, which opens K1A and K1C, which removes power from the high-voltage rectifiers. Before high-voltage can be re-applied to the output connectors, switch S2 must be set to the STBY/RESET position, until the time-delay cycle is completed. Switch S2 may then be set to the HIGH VOLTAGE ON position.

3-6. The main output voltage is developed by CR202 through CR215, C6A, and C6B. This is a full-wave, voltage-doubler circuit, which applies dc voltage to the plates of V301 and V302. The high-voltage taps on the secondary of transformer T1 provide approximate control of the unregulated dc voltage, which minimizes power dissipation in V301 and V302 at low output voltages.

3-7. The output voltage is controlled by the parallel-connected series pass tubes V301 and V302, which are controlled by the feedback amplifier consisting of Q301 through Q304, and Q407 through Q409. Transistors Q408 and Q409 are connected as a differential amplifier, in which the output is proportional to the difference between the two input signals. The input of Q408 is connected to the positive bus, which is reference. The input to Q409 is the summation point of the reference resistors R101, R102, and R425, and the voltage control resistors R103 through R119. The feedback amplifier controls the output voltage so that the summation point is always at, or near, the same potential as the positive output bus. Any voltage difference between these two points is amplified by the differential amplifier, and further amplified by Q407 and Q301 through Q304, and applied to the grids of the series passing tubes. The passing tubes then increase or decrease the output voltage until the voltage at the summation point is equal to the voltage of the positive bus. V401 is a high stable voltage reference tube which maintains a constant voltage of approximately 83 volts. Since the summation point is always at zero volts, V401 causes a constant current to flow through reference resistors R102 and R425. This same constant current flows through the voltage control resistors, and the output voltage is equal to the IR drop across these resistors. The output voltage may thus be precisely controlled by varying the resistance of the voltage control string.

3-8. The feedback amplifier consists of essentially four stages composed of seven silicon transistors. Transistors Q408 and Q409 are connected as a differential amplifier. The output is taken from the collector load of Q409 and applied to the common-emitter amplifier Q407. Output from the collector of Q407 is ac coupled back to the base of Q408 as negative feedback for loop stabilization. The output of Q407 is applied to the input of the compound-connected, emitter-follower pair of Q304 and Q303. This stage provides current gain and impedance matching between the high collector impedance of Q407 and the low emitter impedance of Q302. Q302 and Q301 are common base stages which provide the voltage gain and large voltage swing required by the grids of V301 and V302. C309 and R317 in the emitter of Q302 form a lead network for loop compensation.

3-9. AC voltage for both the positive and negative auxiliary supplies is obtained from one transformer winding. One terminal of this winding is connected to the positive output of the 412B, which is the zero volt

reference. The other terminal of the winding is connected to the junction of two half-wave rectifiers and filters. The positive auxiliary voltage is obtained from CR301, CR302, and C401. Auxiliary voltages of +95 volts, +20 volts, and +10 volts are obtained from CR305, CR306, CR307, and R304, which are connected across the positive auxiliary voltage. A negative auxiliary voltage is obtained from CR303, CR304, and C402. An auxiliary voltage of -110 volts is obtained from CR308 and R305. This arrangement of the +95V, +20V, +10V, and -110V auxiliary supplies provides shunt regulation of these supplies.

3-10. Reference voltage for the instrument is obtained from V401, a gas-filled reference tube. Resistor R415 has a temperature coefficient of +0.45%/°C, which provides temperature compensation for V401. Transistors Q405 and Q406 are used as a differential amplifier. Transistor Q403 is operated as an emitter-follower voltage regulator, which provides a 100 volt source for the collector of Q405 and the emitter of Q404. The base of Q405 samples the output voltage of the +125 volt auxiliary supply, through the voltage divider R408 and R409. The output from Q406 represents the amplified difference between the reference voltage and the voltage at the base of Q405. Transistor Q404 provides further amplification of this voltage difference for application to series regulators Q402 and Q401. Neon lamps DS401 and DS402 are safety devices to prevent burn-out of Q401 and Q402 if the output of the instrument is accidentally short-circuited.

3-11. ACCURACY

3-12. The main sampling string resistors in the 412B are accurate to within ±0.1%. However, the accuracy of the 412B is specified as ±0.25%, because the accuracy also depends upon the repeatability and stability of the reference voltage. The voltage of reference tube V401 (83A1) changes slightly with time due to aging. The accuracy of the instrument will remain within ±0.25% for not less than 30 days. The calibration accuracy may be maintained at better than ±0.25% if the supply is recalibrated more often than the usual calibration period of 30 days.

3-13. The overall accuracy of the meter in the 412B is approximately 3% of full scale, including the tolerances of multiplying and shunting resistors. However, the calibrated voltage controls should be relied upon to indicate the value of the output voltage. For example, if an output voltage of 1000 volts is selected, the meter will indicate between 937 volts and 1063 volts (±3% of 2100 = ±63). However, the actual output voltage will be between 997.5 volts and 1002.5 volts (±0.25% of 1000 = ±2.5). Thus, the voltage indicated by the OUTPUT VOLTAGE dials is 12 times as accurate as the meter indication at full scale, and proportionally more accurate at less than full scale.

3-14. All calibrated power supplies have an accuracy limit (floor) as the output voltage approaches zero. This floor is caused by zero shift in the error amplifier, contact resistance in the sampling string circuit, and the accuracy of the voltage-control resistors used for the least significant digits. The accuracy floor may be reduced by using more expensive components and additional circuitry. However, this results in greater initial cost and longer calibration time. Thus, very low accuracy floors are usually found only in precision calibrators. The 412B has an accuracy of ±0.25% or 100 mv, whichever is greater, with the vernier at zero. Thus, the ±0.25% accuracy is valid down to 40 volts.

SECTION IV

MAINTENANCE

4-1. INTRODUCTION

4-2. Maintenance of the Model 412B DC Power Supply should consist primarily of occasional cleaning, tube replacement, and calibration. Preventive maintenance is discussed in paragraph 4-3. A discussion of troubleshooting and a troubleshooting chart are presented in paragraphs 4-6 through 4-9. Calibration procedures and the equipment necessary are presented in paragraph 4-10.

4-3. PREVENTIVE MAINTENANCE

NOTE

Caution should be exercised when servicing this instrument. The metal shell of some of the electrolytic capacitors may be as much as 2185 volts above chassis ground. Before servicing or removing tubes, all capacitors and plate caps should be shorted to the chassis.

4-4. Periodic cleaning of the Model 412B is desirable because of the high voltage present. Any contamination, particularly on the high voltage capacitors, may cause corona discharge, which will appear as noise in the output voltage. Components may be cleaned with Freon, or with a lint-free rag saturated with denatured alcohol. Ceramic switches may be cleaned using a brush and Metriclene solvent. (Manufactured by the John B. Moore Corp., Nutley, New Jersey.) After cleaning, the ceramic surface should be coated with a 10% solution of Dow Corning silicon fluid (200 viscosity grade). Metriclene may be used as a thinner for the silicon fluid.

4-5. Printed circuit boards in the 412B are coated with a polyurethane compound to prevent moisture absorbtion. If components are replaced, it will be necessary to re-coat the circuit board in the immediate area of the part replaced. Aerosol containers of Epocast, available from Furane Plastics, Inc., Los Angeles, California, provide a convenient way of re-coating the circuit board area. The re-coated circuit board does not require baking.

4-6. TROUBLESHOOTING

4-7. It is recommended that all checks be made with the POLARITY switch turned to the negative output polarity, and when possible, the output voltage set to 500 volts. Most voltages are referred to the positive bus, and when the output polarity is negative, the positive bus is connected to the earth grounded chassis. This affords some protection to the person performing the tests.

4-8. The power supply should be allowed to warmup before troubleshooting. Usually, one-half hour of operation is adequate. Figure 4-1 is a list of various failures and probable causes. Reference to Figure 4-1 will occasionally indicate the cause of a failure. A table of pin voltages for transistors and tubes is given in Figure 4-2. Components may be located by referring to Section V.

4-9. The following paragraphs are specific tests that can be performed on the 412B to facilitate troubleshooting and/or performance testing. A list of equipment required for troubleshooting and calibration is given in Figure 4-3.

a. +10 Volt Supply

(1) Connect the 825A common lead to the 412B chassis ground (shell of the OUTPUT connector).

(2) Connect the 825A positive lead to the junction of CR307 and CR306.

(3) Set the POLARITY switch to negative.

(4) Set the POWER switch to ON.

(5) Set the HIGH VOLTAGE switch to STBY/RESET.

(6) The 825A should indicate +10 (±1) volts.

b. +20 Volt Supply

(1) Connect the 825A common lead to the 412B chassis ground.

(2) Connect the positive 825A lead to the junction of CR306 and CR305.

(3) Set the POLARITY switch to negative.

(4) Set the POWER switch to ON.

(5) Set the HIGH VOLTAGE switch to STBY/RESET.

(6) The 825A should indicate +20 (±2) volts.

c. +95 Volt Supply

(1) Connect the 825A common lead to 412B chassis ground.

SYMPTOM	PROBABLE CAUSE	REMEDY
No output.	Blown fuse.	Check fuse F1, and replace if necessary.
	Open heater of V301 or V302.	If tube will not warm-up, replace.
	Open R425, shorted C411.	Check and replace if necessary.
Constant percentage error in output voltage.	Out of calibration.	Recalibrate per paragraph 4-9.
	Defective R102.	Check and replace if necessary.
Percentage error over part of range.	Defective wirewound resistor in the sampling string.	Set output voltage to maximum and decrease one position at a time until error disappears. The defective resistor will be found at the last switch position in which the error was noted.
Output erratic over part of range.	Same as percentage error over part of range.	
Output erratic over entire range.	Defective V301 or V302.	Check by replacement.
	Defective voltage selector switch, or dirty switch printed-circuit-board.	Replace switch, and/or clean printed circuit board.
	Defective R425, R101, or R102.	Check and replace if necessary.
Output rises to over 2. 1KV and follows line voltage variations.	Defective V301, V302, Q301 through Q304, or Q407, Q408, Q409.	Test and replace if necessary.
	Open R103 through R119.	Test and replace if necessary.
Poor load regulation.	Defective Q301 through Q304, Q407, Q408, or Q409.	Check by replacement.
Output voltage suddenly rises above preset value.	Internal arcing in V301 or V302	Check by replacement.
Noise in output.	Dirty high-voltage switches, capacitors, or switch printed-circuit-board.	Clean per paragraph 4-4.
Excessive drift.	Defective V401, Q408, or Q409.	Check by replacement.
Excessive ripple.	Excessive ripple in +125 volt auxiliary supply.	If auxiliary supply ripple exceeds approximately 5 mv, replace the defective component.
	Defective C411, C412, Q408, Q409.	Check and replace if necessary.
Loss of control	Open R424.	Check and replace if necessary.

TRANSISTOR	VOLTAGE				
	e	b	c		
Q301 - SM4144	-2.4	-3.0	-18		
Q302 - SM4144	10.6	10.0	-2.4		
Q303 - SM4144	15.6	15.0	11.5		
Q304 - CDQ10449	11.5	12.1	15.0		
Q401 - 2N3053	149.4	150	188		
Q402 - 2N3053	125	125.6	155		
Q403 - CDQ10449	101	101.6	125		
Q404 - CDQ10449	101	101.6	126		
Q405 - CDQ10449	82.4	83	101		
Q406 - CDQ10449	82.4	83	102		
Q407 - CDQ10449	5.2	5.6	12.0		
Q408 - CDQ10449	-0.5	0	6		
Q409 - CDQ10449	-0.5	0	6		
TUBE	PIN 1	PIN 2	PIN 3	PIN 5	PIN 8
V301	Plate Cap 740	6.3 VAC	.1	-18	95
V302	Plate Cap 740	0	.1	-18	95
V401	83	0	X	X	X

This chart is to be used under the following conditions: (1) Second OUTPUT VOLTAGE dial set to 500; (2) POLARITY switch set to negative; (3) HIGH VOLTAGE switch set to ON; (4) no load connected to the 412B; (5) Measurements are made with a VTVM using a probe having approximately 10 megohms input impedance and less than 5 pf input capacitance. (6) Line voltage approximately 115V; and (7) Voltages may vary as much as 20% from indicated values, however, the difference between E_e and E_b should be approximately as shown.

4-2. PIN VOLTAGE CHART

(2) Connect the 825A positive lead to the junction of CR305 and R303.
(3) Set the POLARITY switch to negative.
(4) Set the POWER switch to ON.
(5) Set the HIGH VOLTAGE switch to STBY/RESET.
(6) The 825A should indicate +95 (±9.5) volts.

d. -110 Volt Supply

(1) Connect the 825A common lead to 412B chassis ground.
(2) Connect the positive 825A lead to the junction of CR308 and R305.
(3) Set the POLARITY switch to negative.
(4) Set the POWER switch to ON.
(5) Set the HIGH VOLTAGE switch to STBY/RESET.
(6) The 825A should indicate -110 (±11) volts.

e. 125 Volt Auxiliary Supply

(1) Connect the 825A common lead to 412B chassis ground.
(2) Connect the positive 825A lead to the jumper wire on the 412B-404 printed circuit board.
(3) Set the POLARITY switch to negative.
(4) Set the POWER switch to ON.
(5) Set the HIGH VOLTAGE switch to STBY/RESET.
(6) The 825A should indicate 125 (±2.25) volts.

f. Reference Voltage

(1) Connect the 825A common lead to 412B chassis ground.
(2) Connect the 825A positive lead to the shell of the CAL ADJ potentiometer, R425.
(3) Set the POWER switch to ON.
(4) Set the POLARITY switch to negative.
(5) Set the HIGH VOLTAGE switch to STBY/RESET.
(6) The 825A should indicate 82.6 to 84.1 volts. If the measured voltage exceeds 83.75 volts, remove the jumper wire shorting across R101.

g. Stability Test

EQUIPMENT RECOMMENDED	SPECIFICATIONS REQUIRED
Variac, or auto-transformer	Output of 100-to-130 vac, at 3 amperes
Voltage divider, Fluke Model 80E-5	Must be capable of measuring 0 to 2100 vdc with an accuracy of approximately 0.03%.
Differential voltmeter, Fluke Model 825A	
RMS voltmeter, Fluke Model 910A	Must be capable of measuring non-sinusoidal waves.
Oscilloscope, Tektronix Model 541 with Type L plug-in unit	5 mv/cm sensitivity
Resistor, power	16.67K ±3%, 15W
Resistor, composition	1K ±5%, 2W
Blocking Capacitor	0.05 micro-farad, 3,000 vdc rating

Figure 4-3. EQUIPMENT REQUIRED FOR TROUBLESHOOTING AND CALIBRATION

(1) Set the POWER switch to ON.
(2) Set the POLARITY switch to negative.
(3) Set the HIGH VOLTAGE switch to STBY/RESET.
(4) Connect the Fluke 80E-5 Voltage Divider to the OUTPUT connector, and connect the 825A to the 10 v output of the voltage divider. Set the 825A to measure 2000 volts, taking the voltage divider ratio into consideration.
(5) Set the HIGH VOLTAGE switch to ON. The STBY/RESET lamp will extinguish, and the HIGH VOLTAGE ON lamp will illuminate.
(6) Set the OUTPUT VOLTAGE dials for 2000 volts.
(7) After a minimum operation of 30 minutes, record the output voltage of the 412B. After an additional 60 minutes of operation, again record the output voltage of the 412B. The two voltages should not differ by more than 100 millivolts. (200 microvolts with the 80E-5)

h. Output at Zero Volts.

(1) Connect the 825A across the OUTPUT connector.
(2) Set the POWER switch to ON.
(3) Set the POLARITY switch to negative.
(4) Set the HIGH VOLTAGE switch to STBY/RESET.
(5) After the STBY/RESET lamp illuminates, set the HIGH VOLTAGE switch to ON.
(6) Set the OUTPUT VOLTAGE dials to zero.
(7) The 825A should indicate less than 100 millivolts in both output polarities. If not, Q408 and Q409 may be interchanged with another transistor of the same type within the instrument, so that the beta of the two transistors is more nearly equal.

i. Line Regulation and Ripple

(1) Connect the 825A and 910A across the OUTPUT connector. Also connect the oscilloscope across the OUTPUT connector.
(2) Connect the 412B to the Variac, and connect the Variac to a 115 vac source. Set the Variac to 115 vac output.
(3) Set the controls on the 412B as follows:

second OUTPUT VOLTAGE dial	500
remaining OUTPUT VOLTAGE dials	0
HIGH VOLTAGE switch	STBY/RESET
POLARITY switch	negative
POWER switch	ON

(4) After the STBY/RESET lamp illuminates, set the HIGH VOLTAGE switch to ON. The STBY/RESET lamp will extinguish and the HIGH VOLTAGE ON lamp will illuminate.
(5) Null the 825A, then increase the Variac output to 127 vac. The voltage change indicated by the 825A should be less than 5 millivolts. Do not adjust the 825A. Ripple indicated by the 910A and the oscilloscope should not exceed 500 uv rms, and 1 mv peak-to-peak, respectively.
(6) Decrease the Variac output to 103 vac, and repeat the measurements of step (5).
(7) Set the POLARITY switch to positive, and repeat steps (5) and (6).
(8) Disconnect the 825A and the 910A from the OUTPUT connector.
(9) Connect the 80E-5 Voltage Divider to the OUTPUT of the 412B, and connect the 825A to the 10 v output of the voltage divider.
(10) Connect the 3KV blocking capacitor in series with the input of the 910A, and connect the series combination to the OUTPUT of the 412B.
(11) Connect the 412B to the Variac, and set the Variac to 115 vac.
(12) Set the controls on the 412B as follows:

first OUTPUT VOLTAGE dial	1500
second OUTPUT VOLTAGE dial	500
remaining OUTPUT VOLTAGE dials	0
HIGH VOLTAGE switch	STBY/RESET
POLARITY switch	negative
POWER switch	ON

(13) After the STBY/RESET lamp illuminates, set the HIGH VOLTAGE switch to ON. The STBY/RESET lamp will extinguish, and the HIGH VOLTAGE ON lamp will illuminate.
(14) Null the 825A, then increase the Variac output to 127 vac. The voltage change indicated by the voltmeter-voltage divider combination should be less than 20 mv. Do not adjust the 825A. Ripple indicated by the 910A and by the oscilloscope should not exceed 500 uv rms, and 1 mv peak-to-peak, respectively.
(15) Decrease the Variac output to 103 vac, and repeat the measurements of step (14).
(16) Set the POLARITY switch to positive, and repeat steps (14) and (15).

j. Load Regulation

(1) Connect the 825A across the OUTPUT connector.
(2) Connect the 412B to the Variac, and connect the Variac to a 115 vac source. Set the Variac to 103 vac output.

(3) Set the controls on the 412B as follows:

second OUTPUT VOLTAGE dial	500
remaining OUTPUT VOLTAGE dials	0
HIGH VOLTAGE switch	STBY/RESET
POLARITY switch	negative
POWER switch	ON

(4) After the STBY/RESET lamp illuminates, set the HIGH VOLTAGE switch to ON. The STBY/RESET lamp will extinguish, and the HIGH VOLTAGE ON lamp will illuminate.

(5) Null the 825A.

(6) Connect the 16.67K, 15 w load resistor to the OUTPUT of the 412B. The voltage change indicated by the 825A should be less than 5 mv.

(7) Set the POLARITY switch to positive, and disconnect the 16.67K load resistor.

(8) Repeat steps (5) and (6).

4-10. CALIBRATION

a. Reference Current Adjustment

(1) Connect the 80E-5 to the output of the 412B, and connect the 825A to the 10 v output of the 80E-5.

(2) Set the controls on the 412B as follows:

first OUTPUT VOLTAGE dial	1500
second OUTPUT VOLTAGE dial	500
remaining OUTPUT VOLTAGE dials	0
POLARITY switch	negative
HIGH VOLTAGE switch	STBY/RESET
POWER switch	ON

(3) After the STBY/RESET lamp illuminates, set the HIGH VOLTAGE switch to ON. The STBY/RESET lamp will extinguish and the HIGH VOLTAGE ON lamp will illuminate.

(4) Set the differential voltmeter-voltage divider combination to measure 2000 volts. For example, if using the Model 80E-5, set the differential voltmeter to measure 4 volts.

WARNING

Use an insulated screwdriver to adjust R425. The case of this resistor is 85 volts above chassis ground for negative output polarity, and may be as much as 2185 volts above chassis ground for positive output polarity.

(5) Adjust CAL ADJ resistor R425 for a null on the 825A. Within 2 volts of 2000 volts is sufficient 4 mv with the 80E-5). This control may be adjusted through the access hole on the top of the power supply.

b. Overload Current Adjustment

(1) Connect the 1K, 2 w load resistor to the 412B OUTPUT connector.

(2) Set the controls on the 412B as follows:

all OUTPUT VOLTAGE dials	0
POLARITY switch	negative
HIGH VOLTAGE switch	STBY/RESET
POWER switch	ON

(3) After the STBY/RESET lamp illuminates, set the HIGH VOLTAGE switch to ON. The STBY/RESET lamp will extinguish and the HIGH VOLTAGE ON lamp will illuminate.

(4) Set the 412B for maximum current limit by turning R208 completely counter-clockwise. This control may be adjusted through the access hole on the top of the supply.

(5) Set the OUTPUT VOLTAGE dials to that output voltage that will deliver 32 ma to the load resistor. For example, 32 volts will deliver approximately 32 ma to a 1K, 2 w resistor. (If it is desired that overcurrent trip should occur at a lower output current, choose the output voltage of this step to provide the reduced current).

(6) Using an insulated screwdriver, slowly turn R208 clockwise until the overload circuit removes power from the high voltage rectifiers.

c. Meter Calibration

(1) Set the controls on the 412B as follows:

first OUTPUT VOLTAGE dial	1500
second OUTPUT VOLTAGE dial	500
remaining OUTPUT VOLTAGE dials	0
HIGH VOLTAGE switch	STBY/RESET
POWER switch	ON
POLARITY switch	negative

(2) After the STBY/RESET lamp illuminates, set the HIGH VOLTAGE switch to ON. The STBY/RESET lamp will extinguish, and the HIGH VOLTAGE ON lamp will illuminate.

(3) Using an insulated screwdriver, adjust R123 so that the panel meter indicates 2000 (±50) volts.

(4) Set the POLARITY switch to positive and repeat step (3).

SECTION V

LIST OF REPLACEABLE PARTS

5-1. INTRODUCTION

5-2. This section contains information necessary to describe all normally replaceable parts. Separate assembly lists are used to describe the parts on the final assembly and various assemblies and subassemblies. Each list has a corresponding illustration on which the parts for that list are identified. Parts are called out on both lists and illustrations by reference designations from the schematic diagram. Those parts (mechanical) which have no reference designation are shown on the illustrations by Fluke stock number.

5-3. Each list provides the following information on each part:

a. The REFERENCE DESIGNATION column indicates the reference designation used on the schematic diagram.

b. The DESCRIPTION column describes the part in words, along with any applicable values, tolerances, etc. Indentation is used to show assembly, subassembly, and parts relationship. See abbreviations and symbols on next page.

c. Entries in the FLUKE STOCK NUMBER column indicate the number by which Fluke stocks the part. This number should be used when ordering parts from the Fluke factory or your Fluke representative.

d. Entries in the MFR. column indicate a typical manufacture of the part by the manufacturer's code number. Appendix A lists the manufacturers and their code numbers.

e. Entries in the MFR. PART NO. column are part numbers assigned by the manufacturer indicated in the Mfg. column.

f. The number in the TOTAL QTY column indicates the total quantity of the part used in the instrument. "REF" indicates that the total quantity of the part has been previously given. The total quantity of each part is listed the first time the part appears. All other listings of the same part refer back to the reference designation of the first appearance of the part for the total quantity.

g. The number in the REC. QTY. column indicates the recommended spares quantity necessary to support approximately one to five instruments for a period of two years. The basis used to select the recommended spares quantity is that a small group of parts will be required to correct a majority of the problems that occur. Since there is a chance that any part may fail, a stock of at least one of every part used in addition to the recommended parts will be needed for complete maintenance during one year of isolated service.

h. The USE CODE column identifies certain parts which have been added, deleted, or modified during production of the instrument. Each part for which a use code has been assigned may be identified with a particular instrument serial number by consulting the Use Code Effectivity List at the end of this section. These changes are normally made when improved components become available or when the latest circuit improvements are developed by our engineering department. The serial number listed indicates the instruments in which that particular part was used. The symbol "~" is used to indicate an approximate serial number. If a different part should be used for replacement, it is listed by Fluke stock number in the description column.

5-4. HOW TO OBTAIN PARTS

5-5. Standard components have been used whenever possible. Thus, most parts can be obtained locally. However, parts may be ordered directly from the manufacturer using the manufacturer's part number or from Fluke using the Fluke stock number. In addition, the most commonly replaced parts that can not be obtained locally may be obtained from your Fluke representative. If a part you have ordered has been replaced by a new or improved part, Fluke will normally send you this part along with an explanation.

5-6. When ordering parts from Fluke always include:

a. Reference designation, description, and Fluke stock number.

b. Instrument model and serial number.

c. Most structural parts are not listed. In this case, give complete description, function, and location of part.

5-7. ABBREVIATIONS

ac	alternating current
Al	aluminum
assy	assembly
cap	capacitor
car flm	carbon film
cer	ceramic
comp	composition
conn	connector
cps	cycles per second
db	decibel
dc	direct current
dpdt	double pole double throw
dpst	double pole single throw
elect	electrolytic
fxd	fixed
Ge	germanium
gmv	guaranteed minimum value
Hz	hertz (cycles per second)
K	kilohm
kc or Kc	kilocycle
kHz or KHz	kilohertz (kilocycles per/sec)
kv	kilovolt
kva	kilovolt-ampere
ma	milliampere
Mc or MC	megacycle
MHz	megahertz (megacycles per/sec)
meg or M	megohm
met flm	metal film
mfg	manufacturer
mv	millivolt
mw	milliwatt
na	nanoampere
pf	picofarad
piv	peak inverse voltage
plstc	plastic
pp	peak-to-peak
ppm	parts per million
rect	rectifier
res	resistor
rms	root-mean-square
sb	slow-blow
Si	silicon
S/N	serial number
sw	switch
spdt	single pole double throw
spst	single pole single throw
Ta	tantalum
tc	temperature coefficient
tstr	transistor
ua	microampere
uf	microfarad
uv	microvolt
va	volt ampere
vac	alternating current volts
var	variable
vdc	direct current volts
w	watt
wvdc	direct current working volts
ww	wirewound

5-8. PREFIX SYMBOLS

T	tera	10^{12}
G	giga	10^{9}
M	mega	10^{6}
K or k	kilo	10^{3}
h	hecto	10^{2}
da	deka	10
d	deci	10^{-1}
c	centi	10^{-2}
m	milli	10^{-3}
u	micro	10^{-6}
n	nano	10^{-9}
p	pico	10^{-12}
f	femto	10^{-15}
a	anto	10^{-18}

5-9. QUANTITY SYMBOLS

a or amp	ampere
f	farad
h	henry
hr	hour
Ω	ohm
sec	second
v or V	volt
w or W	watt

5-10. SPECIAL NOTES AND SYMBOLS

~ 000	Approximate serial number
Use 0000-000000	Part number indicated should be used if replacement is required.

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
	Final Assembly (See Figure 5-1)	3158-169706	89536	412B-501			
	Front Panel Assembly (See Figure 5-2)	3158-169656	89536	412B-405	1		
	Switch Assembly (See Figure 5-3)	1702-169615	89536	412B-401	1		
	High Voltage Rectifier Assembly (See Figure 5-4)	1702-169623	89536	412B-402	1		
	Series Passing Assembly (See Figure 5-5)	1702-169631	89536	412B-403	1		
	Amplifier Assembly (See Figure 5-6)	1702-169649	89536	412B-404	1		
C1, C2	Cap, cer, 0.01 uf -20/+80%, 500V	1501-105668	56289	29C9B5	4		
C3	Cap, cer, 0.001 uf ±20%, 3KV	1501-105635	56289	29C300	1		
C4, C5	Cap, cer, 0.0022 uf ±20%, 6KV	1501-106831	56289	41C152	1		
C6A, C6B	Cap, oil, 2/2 uf ±20%, 2KV	1505-163782	56289	P49988	1		
J2	Conn, high voltage	2106-162982	95712	3651-1	2		
K1	Relay, armature, DPDT, 230 VAC, 5A	4504-148940	73949	A410-060713-00	1		
K2	Relay, armature, DPST, 230 VAC, 5A	3158-156968	89536	405B-409	1		
K201	Relay, time delay, 115 VAC, 30 sec.	4502-105288	70563	115NO30T	1	1	
P1	Line cord set	6005-102822	91934	019-3, SVT	1		
R1	Res, WW, 2K ±5%, 10W	4706-155416	06136	10F2000	1		
R2	Res, WW, 1K ±5%, 10W	4706-157933	06136	10F1000	1		
R3	Res, comp, 470Ω ±10%, 1W	4704-109710	01121	GB4711	1		
R4	Res, comp, 680Ω ±10%, 1W	4704-109611	01121	GB6811	1		
R5	Res, comp, 100Ω ±10%, 1W	4704-109363	01121	GB1011	1		
R307	Res, comp, 470Ω ±10%, 1/2W	4704-108415	01121	EB4711	2		
R310	Res, comp, 470Ω ±10%, 1/2W	4704-108415	01121	same as R307	REF		
S8	Switch, interlock	5104-115196	01963	E13-00A	1		
T1	Transformer, power	5600-166975	89536	412B-651	1		
V301, V302	Electron Tube, Type 8068	5701-116731	33173	8068	2	1	
	Switch detent, 4 position (part of switch S3)	5108-167825	76854	246306-H	1		
	Switch detent, 6 position (part of switch S4)	5108-155952	76854	239913-H	1		

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
	Switch detent, 10 position (part of switches S5 and S6)	5108-155945	76854	239914-H	2		
	Switch detent, 2 position (part of switch S7)	5108-155960	76854	239912-H	1		
	Switch section (part of switch S3)	5107-167817	76854	Type HC	1	1	
	Knob, 1 inch dia.	2405-101105	04645	S-657-3-BB-L	6		A
	Knob, 13/16 in. dia.	2405-188524	89536	410B-284	6		B
	Rubber feet (not illustrated)	2819-103309	83478	9102-W	4		
	Mating connector (not illustrated)	2106-100735	95712	486-1	1		

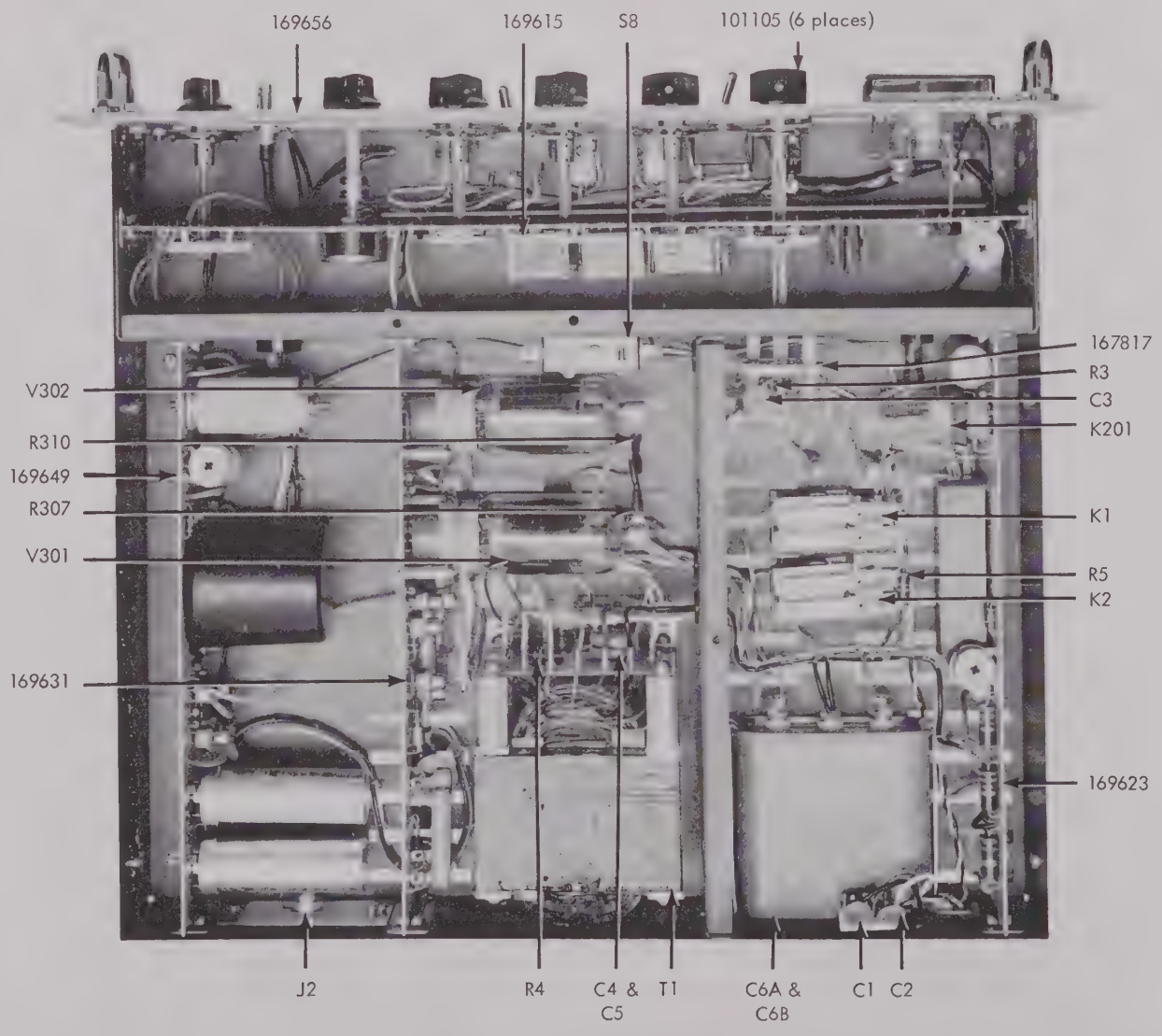


Figure 5-1. FINAL ASSEMBLY (Sheet 1 of 2)

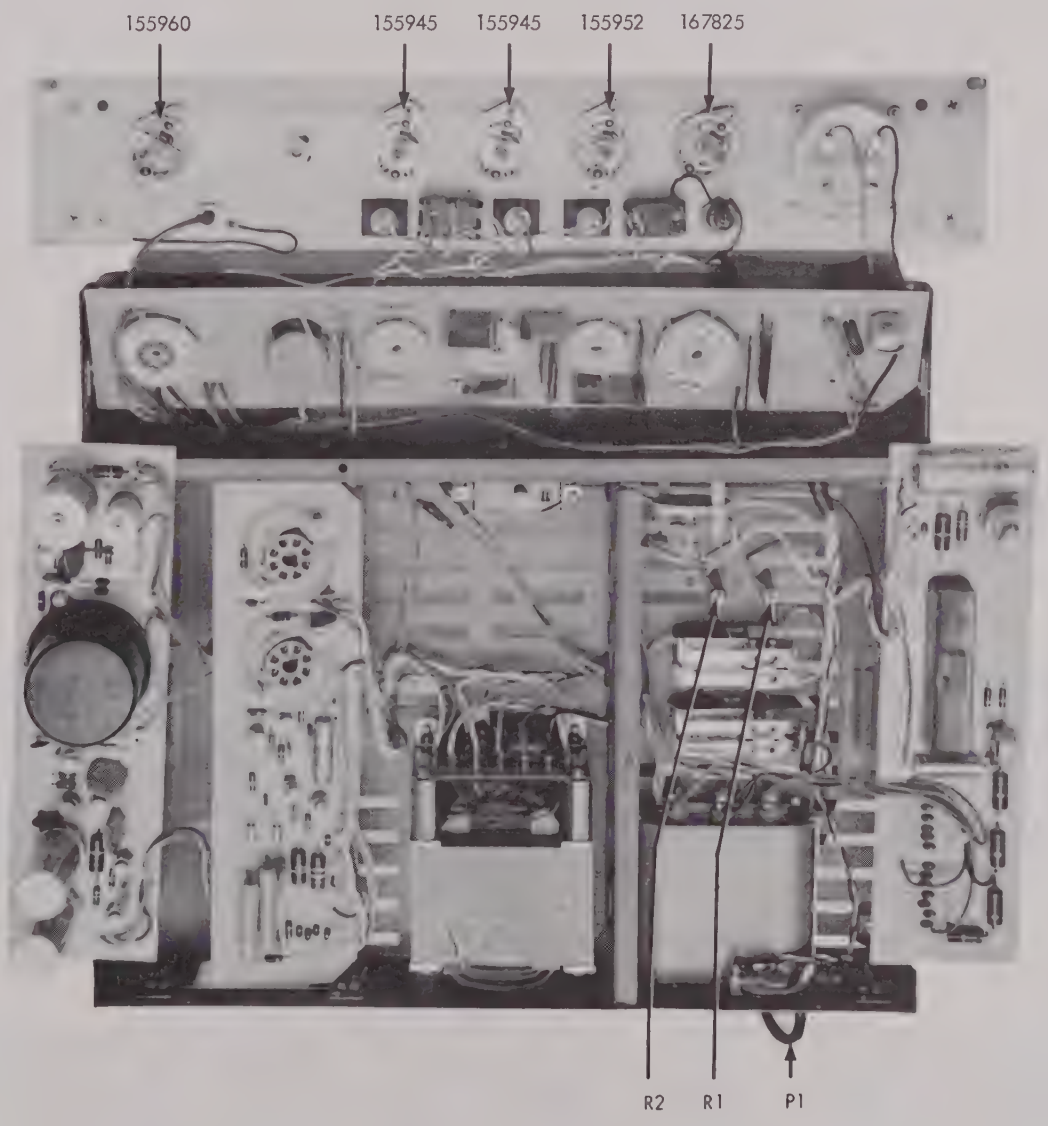


Figure 5-1. FINAL ASSEMBLY (Sheet 2 of 2)

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
	Front Panel Assembly	3158-169656	89536	412B-405	REF		
DS1	Lamp, neon, red	3903-100206	91802	1040A1	2		
DS2	Lamp, neon, white	3903-100214	91802	1040A4	1		
DS3	Lamp, neon, red	3903-100206	91802	same as DS1	REF		
F1	Fuse, 250V, 3A, sb (not illustrated)	5101-109280	03614	Type MDL	1	2	
J1	Conn, high voltage	2106-162982	95712	same as J2	REF		
M1	Meter, 500-0-500 ua ±2%	2901-166256	89536	166256	1		
S1	Switch, toggle, DPST, 250 VAC, 8A	5106-114835	04009	81024-GB	1	1	
S2	Switch, toggle, DPDT, 250 VAC, 10A	5106-157883	73559	2GL50-63	1	1	
	Fuseholder	2102-100107	03614	HKP	1		
	Handle	2404-100412	05704	825	2		

Figure 5-2. FRONT PANEL ASSEMBLY

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
	Switch PCB Assembly	1702-169615	89536	412B-401	REF		
R101	Res, WW, 1.0K ±1%, 1W	4707-131623	89536	34-2001	1	1	
R102	Res, WW, 40K ±0.1%, 1W	4707-146530	89536	34-2057	1	1	
R103, R104, R105	Res, WW, 250K ±0.1%, 2W	4707-156448	89536	34-2206	3	1	
R106, R107	Res, WW, 100K ±0.1%, 1W	4707-142349	89536	34-2045	2	1	
R108	Res, WW, 50K ±0.1%, 1W	4707-156455	89536	34-2208	1	1	
R109 thru R112	Res, WW, 10K ±0.1%, 1W	4707-131664	89536	34-2007	4	1	
R113	Res, WW, 5K ±0.1%, 1/2W	4707-149708	89536	34-2173	2	1	
R114 thru R117	Res, met flm, 1K ±1%, 1/2W	4705-151324	75042	Type CEC-TO	3		
R118	Res, met flm, 499Ω ±1%, 1/2W	4705-151514	75042	Type CEC-TO	1		
R119	Res, var, WW, 600Ω ±10%, 2W	4702-155523	71450	Type 252	1	1	
R120	Res, met flm, 2.67M ±1%, 2W	4705-169391	14298	CM-2	1		
R121	Res, met flm, 1M ±1%, 1/2W	4705-111146	15909	Type DA2	1		
R122	Res, met flm, 422Ω ±1%, 1/2W	4705-150821	75042	CEC-TO	1		
R123	Res, var, WW, 500Ω ±20%, 1-1/4W	4702-113258	71450	Type 110	1	1	
S3	Switch section, rotary, 1 pole	5107-167809	76854	247490-HC	1	1	
S4, S5, S6	Switch section, rotary, 1 pole	5108-155978	76854	239956-FC	3	1	
S7	Switch section, rotary, 2 poles, 2 positions	5108-155929	76854	239955-HO	1	1	

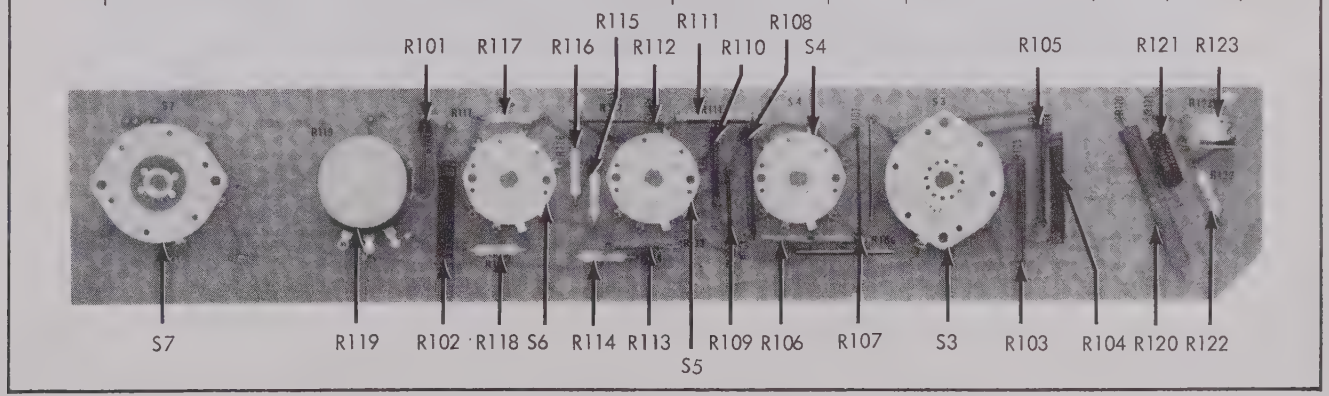


Figure 5-3. SWITCH PRINTED CIRCUIT BOARD ASSEMBLY

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
	High Voltage Rectifier Assembly	1702-169623	89536	412B-402	REF		
C201	Cap, elect, 40 uf -10/+75%, 250V	1502-161273	56289	34D406G-250GL4	1	1	
C202	Cap, elect, 10 uf -10/+75%, 150V	1502-106351	56289	30D106G-150DF4	1	1	
CR201 thru CR215	Diode, si, 600 PIV, 0.75A	4802-112383	14099	SCE6	22	4	
K202	Switch, reed	3158-169698	89536	412B-409	1	1	
R201	Res, comp, 10Ω ±10%, 2W	4704-110163	01121	HB1001	1		
R202	Res, comp, 68K ±10%, 1W	4704-109629	01121	GB6831	1		
R203 thru R206	Res, comp, 2.2M ±10%, 2W	4704-167304	01121	HB2251	4		
R208	Res, var, WW, 1K ±20%, 1-1/4W	4702-113266	71450	Type 110	2	1	
R209	Res, comp, 47Ω ±10%, 1/2W	4704-108688	01121	EB4701	1		

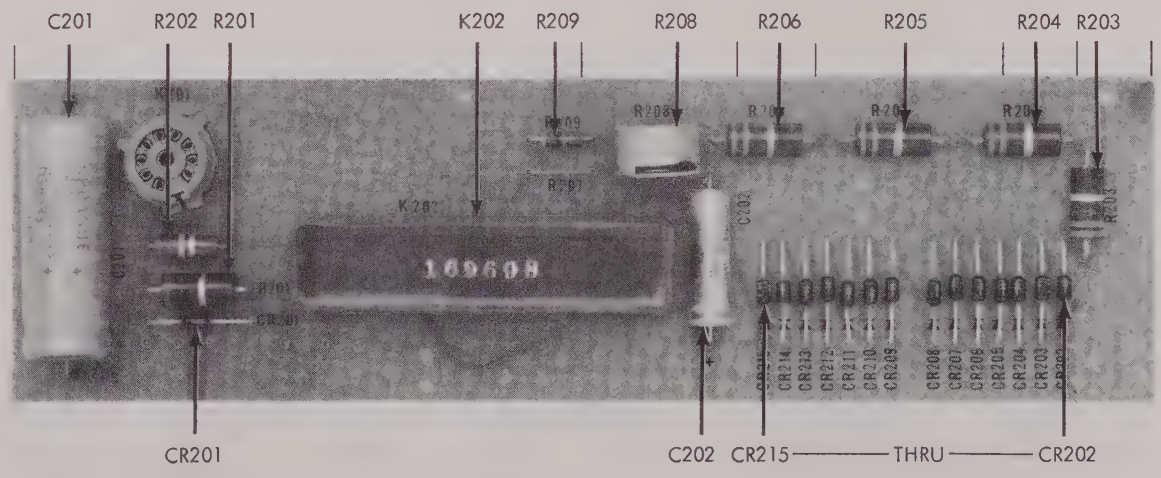


Figure 5-4. HIGH VOLTAGE RECTIFIER ASSEMBLY

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
	Series Passing Assembly	1702-169631	89536	412B-403	REF		
C301	Cap, cer, 0.0033 uf ±20%, 1KV	1501-106674	56289	5GA-D33	1		
C302	Cap, elect, 200 uf -10/+25%, 12V	1502-150284	56289	30D207G-012DF4	1	1	
C303	Cap, cer, 0.1 uf -20/+80%, 500V	1501-105684	56289	41C92	5		
C307, C308	Cap, cer, 0.01 uf -20/+80%, 500V	1501-105668	56289	same as C1	REF		
C309	Cap, cer, 180 pf ±10%, 500V	1501-105890	71590	BB60181KS3N	1		
CR301 thru CR304	Diode, si, 600 PIV, 0.75A	4802-112383	14099	same as CR201	REF		
CR305	Diode, si, zener, 75V, 5 ma, type IN3041A	4803-168096	81483	IN3041A	1	1	
CR306, CR307	Diode, si, zener, 10V, 12.5 ma, type IN961A	4803-113324	07910	IN961A	2	1	
CR308	Diode, si, zener, 110V, 5 ma, type IN3045A	4803-168104	81483	IN3045A	1	1	
CR309	Diode, si, 600 PIV, 0.75A	4802-112383	14099	same as CR201	REF		
Q301, Q302, Q303	Tstr, PNP, si, type SM4144	4805-190389	04713	SM4144	3	2	
Q304	Tstr, NPN, si, type CDQ10449	4805-153551	07910	CDQ10449	8	3	
R301	Res, comp, 10Ω ±10%, 1/2W	4704-108092	01121	EB1001	1		
R302	Res, comp, 220Ω ±10%, 1/2W	4704-108191	01121	EB2211	1		
R303, R304	Res, WW, 30K ±5%, 10W	4706-155432	06136	10F30000	2		
R305	Res, comp, 150K ±10%, 2W	4704-109959	01121	HB1541	1		
R306	Res, comp, 1K ±10%, 1/2W	4704-108563	01121	EB1021	4		
R308	Res, comp, 100Ω ±10%, 1/2W	4704-108100	01121	EB1011	2		
R309	Res, comp, 1K ±10%, 1/2W	4704-108563	01121	same as R306	REF		
R311	Res, comp, 100Ω ±10%, 1/2W	4704-108100	01121	same as R308	REF		
R312	Res, comp, 68K ±10%, 2W	4704-110114	01121	HB6831	1		
R313, R314	Res, comp, 1K ±10%, 1/2W	4704-108563	01121	same as R306	REF		
R315, R316	Res, comp, 47K ±10%, 1/2W	4704-108480	01121	EB4731	4		

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
R317	Res, comp, 270Ω ±10%, 1/2W	4704-108241	01121	EB2711	1		
R318	Res, comp, 680Ω ±10%, 1/2W	4704-108712	01121	EB6811	1		
R319	Res, comp, 47K ±10%, 1/2W	4704-108480	01121	same as R315	REF		
R320	Res, comp, 4.7K ±10%, 1/2W	4704-108381	01121	EB4721	2		

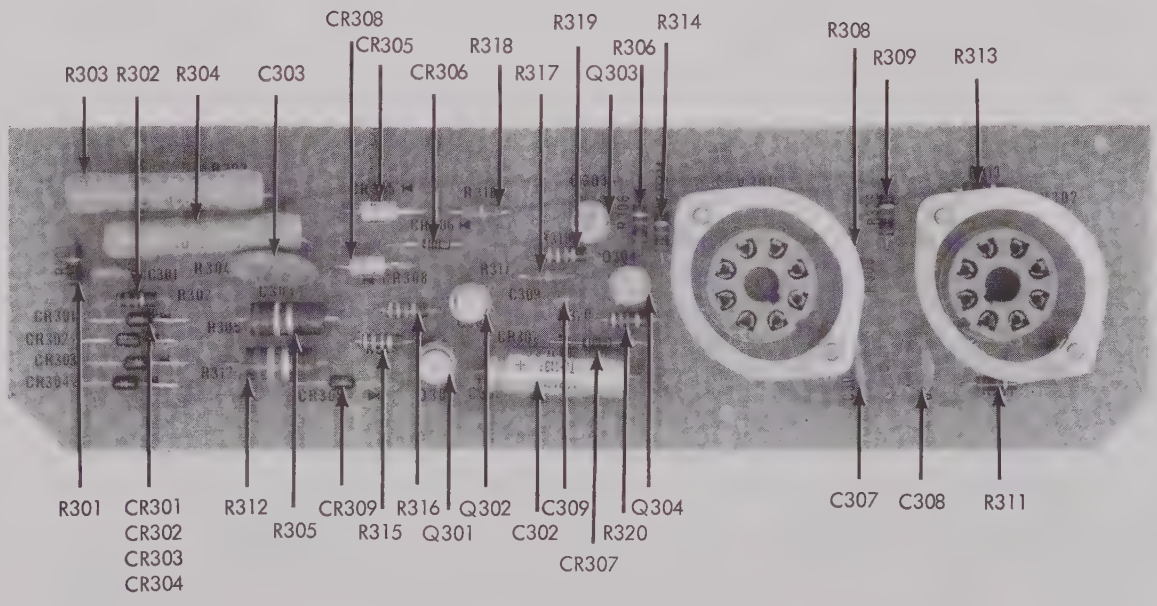


Figure 5-5. SERIES PASSING ASSEMBLY

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
	Amplifier Assembly (without tubes)	1702-169649	89536	412B-404	REF		
C401, C402	Cap, elect, 40 uf -10/+100%, 500V	1502-106765	56289	Type 66D	2	1	
C403	Cap, cer, 0.1 uf -20/+80%, 500V	1501-105684	56289	same as C303	REF		
C404	Cap, cer, 0.0047 uf ±10%, 500V	1501-106724	71590	CF-472	1		
C405, C406	Cap, cer, 0.1 uf -20/+80%, 500V	1501-105684	56289	same as C303	REF		
C407	Cap, cer, 0.05 uf -20/+80%, 500V	1501-105676	56289	33C58	1		
C408	Cap, cer, 0.0027 uf GMV, 600V	1501-106211	72982	ED-.0027	1		
C409	Cap, cer, 0.1 uf -20/+80%, 500V	1501-105684	56289	same as C303	REF		
C410	Cap, cer, 0.01 uf GMV, 1.6KV	1501-106930	71590	DD16-103	1		
C411	Cap, oil, 0.05 uf ±10%, 2KV	1505-161166	01884	SMLE503-2M	1		
C412	Cap, oil, 0.25 uf ±10%, 2KV	1505-161174	01884	SMLE254-2M	1		
CR401, CR402	Diode, si, 100 PIV, 1A	4802-116111	14099	SCE1	2	2	
CR403, CR404	Diode, si, 600 PIV, 0.75A	4802-112383	14099	same as CR201	REF		
DS401, DS402	Lamp, neon, type NE2E	3902-100347	71744	NE2E	2	2	
Q401, Q402	Tstr, NPN, si, type 2N3053	4805-150359	95303	2N3053	2	2	
Q403 thru Q409	Tstr, NPN, si, type CDQ10449	4805-153551	07910	same as Q304	REF		
R401	Res, comp, 2.7K ±10%, 2W	4704-110148	01121	HB2721	1		
R402, R403	Res, comp, 6.2K ±5%, 1/2W	4704-108621	01121	EB6225	2		
R404	Res, met flm, 20K ±1%, 1/2W	4705-162438	75042	Type CEC-TO	1		
R405	Res, met flm, 100K ±1%, 1/2W	4705-151316	75042	Type CEC-TO	1		
R406	Res, comp, 47K ±10%, 1/2W (not illustrated)	4704-108480	01121	same as R315	REF		
R407	Res, comp, 2.7K ±10%, 1/2W	4704-108837	01121	EB2721	1		
R408	Res, met flm, 40.2K ±1%, 1/2W	4705-161059	75042	Type CEC-TO	1		
R409	Res, met flm, 80.6K ±1%, 1/2W	4705-150680	75042	Type CEC-TO	1		
R410	Res, comp, 180K ±10%, 1/2W	4704-108431	01121	EB1841	1		

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
R411	Res, comp, 39K ±10%, 1/2W	4704-108555	01121	EB3931	1		
R412	Res, comp, 330Ω ±10%, 1/2W	4704-108589	01121	EB3311	1		
R413	Res, comp, 82K ±10%, 1/2W	4704-108498	01121	EB8231	1		
R414	Res, WW, 4K ±0.03%, 1/2W	4707-131672	89536	34-2008	1	1	
R415	Res, WW, 14K at 25°C +.45%/°C	4707-172072	89536	34-4002	1		
R416	Res, WW, 5K ±0.1%, 1/2W	4707-149708	89536	same as R113	REF		
R417	Res, comp, 100K ±10%, 1/2W	4704-108126	01121	EB1041	1		
R418	Res, comp, 4.7K ±10%, 1/2W	4704-108381	01121	same as R320	REF		
R419	Res, met flm, 1K ±1%, 1/2W	4705-151324	75042	same as R114	REF		
R420	Res, comp, 1.2M ±10%, 1/2W	4704-108407	01121	EB1251	1		
R421, R422	Res, comp, 270K ±10%, 1/2W	4704-108258	01121	EB2741	2		
R423	Res, comp, 2.2K ±10%, 1/2W	4704-108605	01121	EB2221	1		
R424	Res, met flm, 1K ±1%, 1/2W	4705-151324	75042	same as R114	REF		
R425	Res, var, WW, 1K ±20%, 1-1/4W	4702-113266	71450	same as R208	REF		
R426	Res, comp, 2.7Ω ±10%, 1W	4704-109850	01121	GB27G1	1		
V401	Electron tube, voltage reference, Aged 83A1	5701-170076	89536	412B-410	1	1	

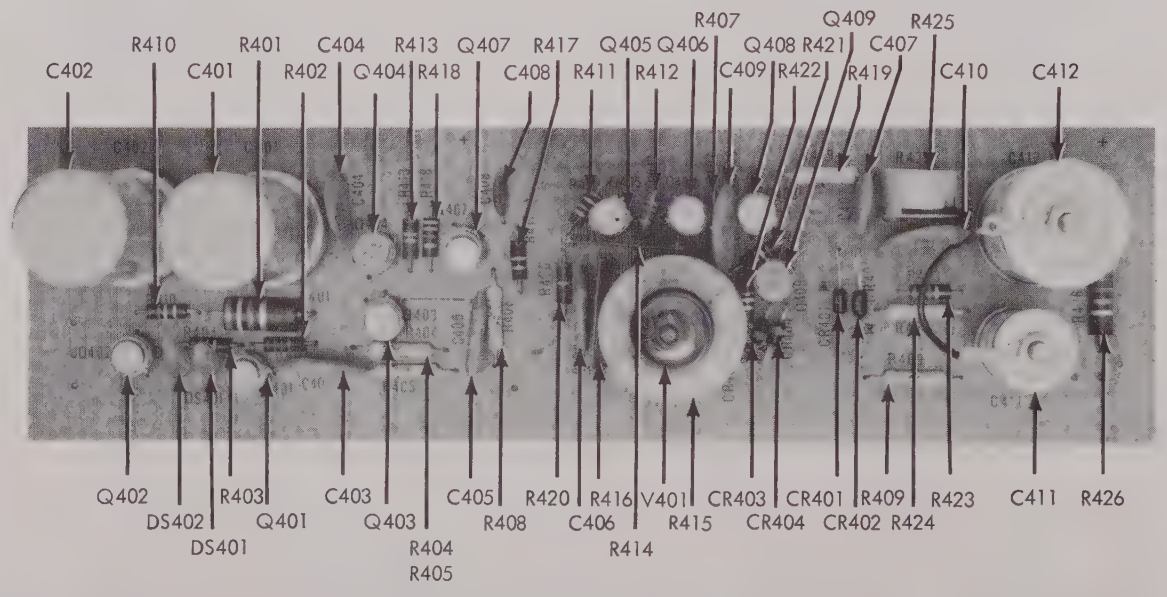


Figure 5-6. AMPLIFIER ASSEMBLY

5-10 USE CODE EFFECTIVITY

The following list of use codes is intended to allow the customer to determine the effectivity of all replaceable parts. All parts with no code are used on all instruments with serial numbers above 123. New codes will be added as necessary on forthcoming instruments.

USE CODE	EFFECTIVITY
No Code	Model 412B serial number 123 and on
A	Model 412B serial number 123 thru 272, 277 thru 349
B	Model 412B serial number 273, 274, 275, 276, 350 and on

APPENDIX A

FEDERAL SUPPLY CODE FOR MANUFACTURERS

A-1. CODE TO NAME

A-2. The following five-digit code numbers are listed in numerical sequence along with the manufacturer's name and address to which the code has been assigned. The Federal Supply Code has been taken from Cataloging Handbook H 4-2, Code to Name. Suppliers not listed in the Federal Supply Code for Manufacturers have been assigned an alphabetical code by FLUKE.

00213	Sage Electronics Corp. Rochester, New York
00327	Welwyn International, Inc. Cleveland, Ohio
00656	Aerovox Corp. New Bedford, Massachusetts
01121	Allen-Bradley Company Milwaukee, Wisconsin
01281	Pacific Semiconductors Inc. Lawndale, California
01295	Texas Instruments, Inc. Semiconductor Components Div. Houston, Texas
01730	Circle Mfg. Co. Inc. Little Falls, New Jersey
01884	Dearborn Electronic Labs Inc. Orlando, Florida
01963	Cherry Electrical Products Corp. Highland Park, Illinois
02660	Amphenol-Borg Elect. Corp. Chicago, Illinois
02606	Fenwal Laboratories Inc. Framington, Massachusetts
02799	Arco Capacitors, Inc. Los Angeles, California
03614	Bussmann Mfg. Div. of McGraw-Edison Co. Los Angeles, California
03615	Ohmite Mfg. Co. Los Angeles, California
03877	Transitron Electronic Corp. Wakefield, Massachusetts
03911	Clairex Corp. New York, New York
03980	Muirhead Instruments, Inc. Mountainside, New Jersey
04009	Arrow Hart and Hegemen Electronic Company Hartford, Connecticut
04062	Elmenco Products Company New York, New York
04202	Winchester Electronics Co. New Milford, Connecticut
04221	Telex-Aemco Division of Telex Corp. Mankato, Minnesota
04645	Kurz-Kasch, Inc. Chicago, Illinois
04713	Motorola Inc. Semiconductor Products Division Phoenix, Arizona
05082	Tung-Sol Electric Inc. Melrose Park, Illinois
05278	Penn-East Engrg. Corp. Kutztown, Pennsylvania
05397	Union Carbide Corp. Linde Division Kemet Dept. Cleveland, Ohio
05571	Sprague Electric Company Culver City, California
05704	Alac, Inc. Glendale, California
06001	General Electric Company Capacitor Department Irmo, South Carolina
06136	Ward Leonard Electric Co. Los Angeles, California
06473	Amphenol Space and Missile Sys Chatsworth, California
06555	Beede Electrical Inst. Co. Penacook, New Hampshire
06751	Nuclear Corporation of America, Inc. U. S. Semcor Div. Phoenix, Arizona
06860	Gould National Batteries Inc. La Puente, California
07115	Corning Glass Works Electronic Components Dept. Bradford, Pennsylvania
07263	Fairchild Semiconductor Div. of Fairchild Camera and Instrument Corp. Mountain View, California
07344	Bircher Co., Inc. Rochester, New York
07792	Lerma Engineering Corp. Northampton, Massachusetts
07910	Continental Device Corp. Hawthorne, California
08530	Reliance Mica Corp. Brooklyn, New York
08863	Nylomatic Corp. Morrisville, Pennsylvania
08988	Skottie Electronics Inc. Peckville, Pennsylvania
11237	Chicago Telephone of Calif Inc. South Pasadena, California
11503	Keystone Mfg. Co. Warren, Michigan
12060	Diodes, Inc. Chatsworth, California
12136	Philadelphia Handle Co. Camden, New Jersey
12400	International Resistance Co. Control Components Division Philadelphia, Pennsylvania
12617	Hamlin Inc. Lake Mills, Wisconsin
12697	Clarostat Mfg. Co. Dover, New Hampshire
14099	Semtech Corp. Newbury Park, California
14193	California Resistor Corp. Santa Monica, California
14298	American Components Inc. Conshohocken, Pennsylvania
14752	Electro Cude Inc. South Pasadena, California
15818	Amelco Inc. Mountain View, California
15909	Daven Division Thomas A. Edison Ind. McGraw Edison Co. Livingston, New Jersey
16332	Milwaukee Relays Inc. Cedarburg, Wisconsin
16473	Cambridge Scientific Industries Inc. Cambridge, Maryland
17069	Circuit Structures Lab Santa Ana, California
17856	Siliconix Inc. Sunnyvale, California
17910	Continental Device Corp. Hawthorne, California
18083	Clevite Corp. Transistor Division Palo Alto, California
19429	Montronics, Inc. Seattle, Washington
19701	Electra Mfg. Co. Independence, Kansas
24655	General Radio Co. West Concord, Mass.
28520	Heyman Mfg. Co. Kenilworth, New Jersey
33173	General Electric Co. Tube Dept. Owensboro, Kentucky
37942	P. R. Mallory and Co., Inc. Indianapolis, Indiana
38315	Honeywell Inc. Precision Meter Division Manchester, New Hampshire
42498	National Company, Inc. Malden, Massachusetts
44655	Ohmite Mfg. Co. Skokie, Illinois
49671	Radio Corp. of America New York, New York
53021	Sangamo Electric Co. Springfield, Illinois
55026	Simpson Electric Company Chicago, Illinois
56289	Sprague Electric Co. North Adams, Mass.
58474	Superior Electric Co. Bristol, Connecticut
60399	Torrington Mfg. Co. Torrington, Connecticut
62460	USHCO Mfg. Co., Inc. Buffalo, New York
64834	West Mfg. Co. San Francisco, California
65092	Weston Instruments Div. of Daystrom, Inc. Newark, New Jersey
66150	Winslow Tele-Tronics Inc. Asbury Park, New Jersey
70563	Amperite Co. Union City, New Jersey
70903	Belden Mfg. Co. Chicago, Illinois

71400 Bussman Manufacturing Division of McGraw Edison Co. St. Louis, Missouri

71450 CTS Corp. Elkhart, Indiana

71468 Cannon Electric Company Los Angeles, California

71482 Clare, C. P. and Company Chicago, Illinois

71590 Centralab Div. of Globe Union, Inc. Milwaukee, Wisconsin

71707 Coto Coil Co., Inc. Providence, Rhode Island

71744 Chicago Miniature Lamp Works Chicago, Illinois

71785 Cinch Mfg. Co. and Howard B. Jones Div. Chicago, Illinois

72005 Driver, Wilber B., Co. Newark, New Jersey

72092 Eitel-McCullough, Inc. San Bruno, California

72136 Electro Motive Mfg. Co. Willimantic, Connecticut

72354 Fast, John E. Co. Div. of Victoreen Instr. Co. Chicago, Illinois

72559 Essex Electronics Inc. Berkeley Heights, New Jersey

72619 Dialight Corp. Brooklyn, New York

72665 Mallory Battery Company Cleveland, Ohio

72982 Erie Tech. Products Inc. Erie, Pennsylvania

73138 Helipot Division of Beckman Instruments Inc. Fullerton, California

73293 Hughes Products Div. of Hughes Aircraft Co. Newport Beach, California

73445 Amperex Electronic Co. Div. of North American Philips Co., Inc. Hicksville, New York

73559 Carling Electric Inc. Hartford, Connecticut

73586 Circle F Mfg. Co. Trenton, New Jersey

73899 JFD Electronics Corp. Brooklyn, New York

73949 Guardian Electric Mfg. Co. Chicago, Illinois

74217 Radio Switch Corp. Marlboro, New Jersey

74306 Piezo Crystal Company Carlisle, Pennsylvania

74542 Hoyt Elect. Instr. Works Penacook, New Hampshire

74970 Johnson, E. F., Co. Waseca, Minnesota

75042 International Resistance Co. Philadelphia, Pennsylvania

75915 Littelfuse Inc. Des Plaines, Illinois

76854 Oak Mfg. Co. Crystal Lake, Illinois

77342 American Machine and Foundry Company Potter & Brumfield Div. Princeton, Indiana

77969 Rubbercraft Corp. of California Ltd. Torrance, California

78277 Sigma Instruments, Inc. South Braintree, Mass.

79136 Waldes Kohinoor Inc. Long Island City, New York

79497 Western Rubber Company Goshen, Indiana

80031 Mepco Division of Sessions Clock Co. Morristown, New Jersey

80294 Bourns Laboratories, Inc. Riverside, California

80583 Hammarlund Company, Inc. New York, New York

80640 Stevens, Arnold Co., Inc. Boston, Massachusetts

81073 Grayhill Company La Grange, Illinois

81439 Therm-O-Disc Inc. Mansfield, Ohio

81483 International Rectifier Corp El Segundo, California

81590 Korry Mfg. Co. Seattle, Washington

82376 Astron Division Renwell Industries Inc. East Newark, New Jersey

82389 Switchcraft Inc. Chicago, Illinois

82872 Roanwell Corp. Brooklyn, New York

82877 Rotron Mfg. Co., Inc. Woodstock, New York

82879 Royal Electric Corp. Pawtucket, Rhode Island

83003 Varo Mfg. Co., Inc. Garland, Texas

83298 Bendix Corp. Red Bank Division Red Bank, Eatontown, New Jersey

83330 Smith, Herman H., Inc. Brooklyn, New York

83478 Rubbercraft Corp. of Am. New Haven, Connecticut

84411 Good All Electric Mfg. Co. Ogallala, Nebraska

86689 R. M. B. Corp. Los Angeles, California

88419 Cornell-Dubilier Elec. Corp. Electro-Mechanical Div. Fuquay Springs, North Carolina

88690 Essex Wire Corp. R. B. M. Division Detroit, Michigan

89536 Fluke, John, Mfg. Co., Inc. Seattle, Washington

89730 General Electric Company Newark Lamp Works of Lamp Division of Consumer Products Group GECO Newark, New Jersey

90205 Best Stamp and Mfg. Co. Kansas City, Missouri

90211 Square D Company Chicago, Illinois

90303 Mallory Battery Company North Tarrytown, New York

91293 Johanson Mfg. Co. Boonton, New Jersey

91407 Superior Electric Company Oak Park, Illinois

91662 Elco Corp. Willow Grove, Penn.

91737 Gremar Mfg. Co., Inc. Wakefield, Massachusetts

91802 Industrial Devices, Inc. Edgewater, New Jersey

91929 Minneapolis Honeywell Regulator Company Micro Switch Division Freeport, Illinois

91934 Miller Electric Co., Inc. Pawtucket, Rhode Island

93332 Sylvania Electric Products Inc. Semiconductor Products Division Woburn, Massachusetts

94145 Raytheon Company Semiconductor Division California Street Plant Newton, Massachusetts

95146 Alco Electronics Mfg. Co. Lawrence, Massachusetts

95264 Lerco Electronics Inc. Burbank, California

95303 Radio Corp. of America Comm. Receiving Tube & Semiconductor Division Cincinnati, Ohio

95354 Methode Mfg. Co. Chicago, Illinois

95712 Dage Electric Co., Inc. Franklin, Indiana

96733 San Fernando Electric Mfg. Co. San Fernando, California

96881 Thomson Industries, Inc. New Hyde Park Long Island, New York

97945 S. S. White Dental Mfg. Co. Plastics Division New York, New York

97966 CBS Electronics Div. of Columbia Broadcasting System, Inc. Danvers, Massachusetts

98094 Penta Laboratories, Inc. Santa Barbara, California

98388 Accurate Sales Company Culver City, California

98743 James Vibrapower Corp. Chicago, Illinois

98925 Semiconductor Division of Clevite Corp. Waltham, Massachusetts

99120 Plastic Capacitors, Inc. Chicago, Illinois

99217 Southern Electronics Corp. Burbank, California

99515 Marshall Industries Electron Prod. Div. Pasadena, California

Revised May 15, 1966
Using H4-2 Dated March 1963

WARRANTY

The JOHN FLUKE MFG. CO., INC. warrants each instrument manufactured by them to be free from defects in material and workmanship. Their obligation under this Warranty is limited to servicing or adjusting an instrument returned to the factory for that purpose, and to making good at the factory any part or parts thereof; except tubes, fuses, choppers and batteries, which shall, within one year after making delivery to the original purchaser, be returned by the original purchaser with transportation charges prepaid, and which upon their examination shall disclose to their satisfaction to have been thus defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at a nominal cost. In this case, an estimate will be submitted before work is started, if requested.

If any fault develops, the following steps should be taken.

1. Notify the John Fluke Mfg. Co., Inc., giving full details of the difficulty, and include the Model number, type number, and serial number. On receipt of this information, service data or shipping instructions will be forwarded to you.

2. On receipt of the shipping instructions, forward the instrument prepaid, and repairs will be made at the factory. If requested, an estimate of the charges will be made before the work begins, provided the instrument is not covered by the Warranty.

SHIPPING

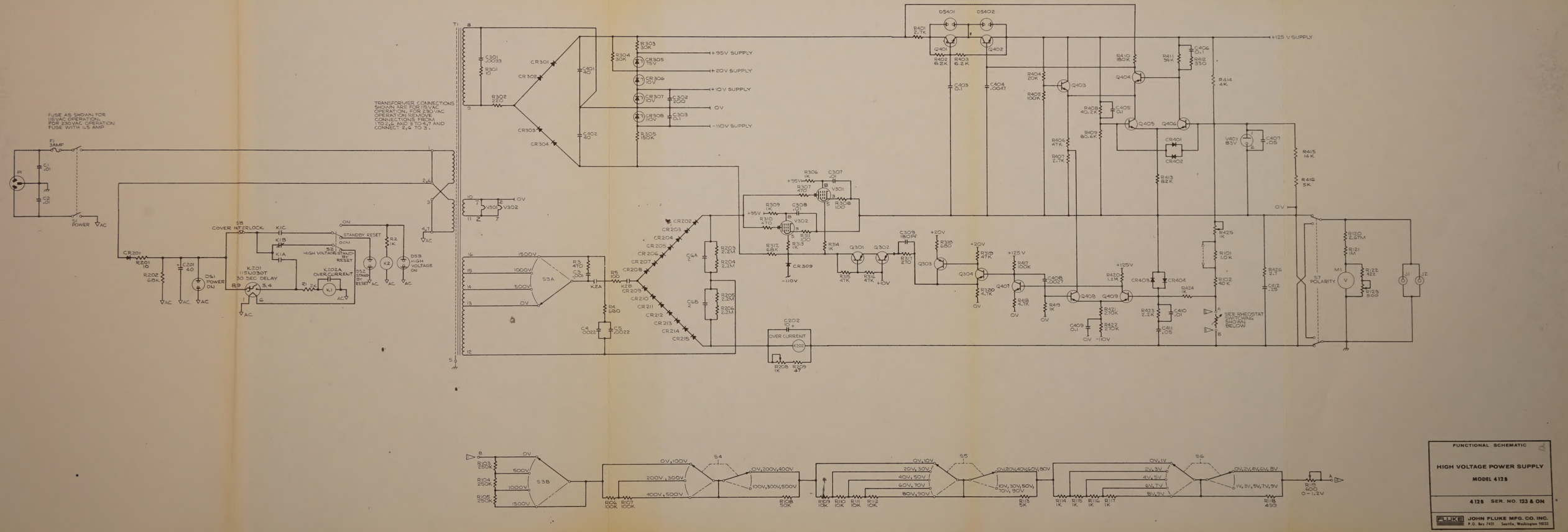
All shipments of John Fluke Mfg. Co., Inc. instruments should be made via Railway Express prepaid. The instrument should be shipped in the original packing carton; or if it is not available, use any suitable container that is rigid. If a substitute container is used, the instrument should be wrapped in paper and surrounded with at least four inches of excelsior or similar shock-absorbing material.

CLAIM FOR DAMAGE IN SHIPMENT

The instrument should be thoroughly inspected immediately upon receipt. All material in the container should be checked against the enclosed packing list. The manufacturer will not be responsible for shortages against the packing sheet unless notified immediately. If the instrument fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent, and this report should be forwarded to John Fluke Mfg. Co., Inc. Upon receipt of this report you will be advised of the disposition of the equipment for repair or replacement. Include the model number, type number, and serial number when referring to this instrument for any reason.

The John Fluke Mfg. Co., Inc. will be happy to answer all application questions which will enhance your use of this instrument. Please address your requests to:

JOHN FLUKE MFG. CO., INC., P. O. BOX 7428, SEATTLE 33, WASHINGTON


FUSE AS SHOWN FOR 115 VAC OPERATION. FOR 230 VAC OPERATION FUSE WITH 1.5 AMP
TRANSFORMER CONNECTIONS SHOWN ARE FOR 115 VAC OPERATION. FOR 230 VAC OPERATION REMOVE CONNECTIONS FROM 1 TO 2,6 AND 3 TO 4,7 AND CONNECT 2,6 TO 3.
F1 3AMP
P1
C1 .01
S2 POWER
S1 POWER ON
C201 40
DS1 POWER ON
CR201 RZ501 10
R202 68K
S3 COVER INTERLOCK
K1C
K1B
K1A
K201 115/230T 30 SEC. DELAY
K202A OVER-CURRENT
R1 1K
K1
DS2 STAND BY RESET
S2A STANDBY RESET
S2B HIGH VOLTAGE RESET
R2 1K
K2
DS3 HIGH VOLTAGE ON
T1
C301 .0033
R301 10
R302 220
CR301
CR302
CR303
CR304
C401 40
C402 40
R303 30K
DS305 75V
+95V SUPPLY
R304 30K
CR306 15V
+20V SUPPLY
CR307 15V
C302 200
+10V SUPPLY
DS308 110V
C303 0.1
0V
R305 150K
-110V SUPPLY
V301 V302
1500V
1000V
500V
0V
S3A
R3 470
C3 .001
K2A
K2B
R5 100
R6 680
C4 .0022
C5 .0022
CR202
CR203
CR204
CR205
CR206
CR207
CR208
CR209
CR210
CR211
CR212
CR213
CR214
CR215
C6A 2
C6B 2
R203 2.2M
R204 2.2M
R205 2.2M
R206 2.2M
C202 10 OVER CURRENT
K202
R208 1K
R209 47
R306 1K
C307 .01
R307 2.2K
R308 100
R309 1K
C308 .01
R310 1K
R312 681K
R313 1K
R314 1K
CR309
-110V
C309 180PF
R310 1.0M
Q301
Q302
R316 47K
+10V
+20V
R335 680
Q303
R315 47K
Q304
R320 4.7K
+125 V
R417 100K
Q407
R418 4.7K
C408 .0027
R419 1K
0V
DS401
DS402
R401 2.7K
Q401
Q402
R402 6.2K
R403 6.2K
C403 .01
C404 .0047
R404 20K
R405 100K
Q403
R408 40.2K
R409 80.6K
R410 180K
Q404
R411 39K
C406 0.1
R412 330
C405 0.1
Q405
Q406
CR401
CR402
R413 82K
+125 V SUPPLY
R414 4K
V401 83V
C407 .05
R415 14K
R416 5K
0V
R425 1K
R101 1.0K
R102 40K
R424 1K
R420 1.2M
CR403
CR404
R421 270K
R422 270K
Q408
Q409
R423 2.2K
C410 .01
C411 .05
C409 0.1
0V -110V
SEE RHEOSTAT SWITCHING SHOWN BELOW
R426 2.7
C412 .25
S7 POLARITY
M1
R120 2.27M
R121 1M
R122 432
R123 500
J1
J2
S4
S3B
R103 250K
R104 250K
R105 250K
0V,100V
200V,300V
400V,500V
0V,200V,400V
100V,300V,500V
R106 100K
R107 100K
R108 50K
S5
0V,10V
20V,30V
40V,50V
60V,70V
80V,90V
0V,20V,40V,60V,80V
10V,30V,50V
70V,90V
R109 10K
R110 10K
R111 10K
R112 10K
R113 5K
S6
0V,1V
2V,3V
4V,5V
6V,7V
8V,9V
0V,2V,4V,6V,8V
1V,3V,5V,7V,9V
R114 1K
R115 1K
R116 1K
R117 1K
R118 49.9
R119 600 0-1.2V
FUNCTIONAL SCHEMATIC
HIGH VOLTAGE POWER SUPPLY
MODEL 412B
412B SER. NO. 123 & ON
FLUKE
JOHN FLUKE MFG. CO. INC.
P.O. Box 7428 Seattle, Washington 98133

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